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[54] **HIGH SPEED SEPARATOR WITH MOVABLE HOLD BACK BELT FOR HIGH SPEED FLATS FEEDER**

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[51] **Int. Cl.**[6] **B65H 5/00**

[52] **U.S. Cl.** **271/10.07**; 271/35; 271/122; 271/270; 271/272; 271/265.02; 271/265.04

[58] **Field of Search** 271/35, 122, 265, 271/270, 272–274, 312, 182, 307, 259, 10

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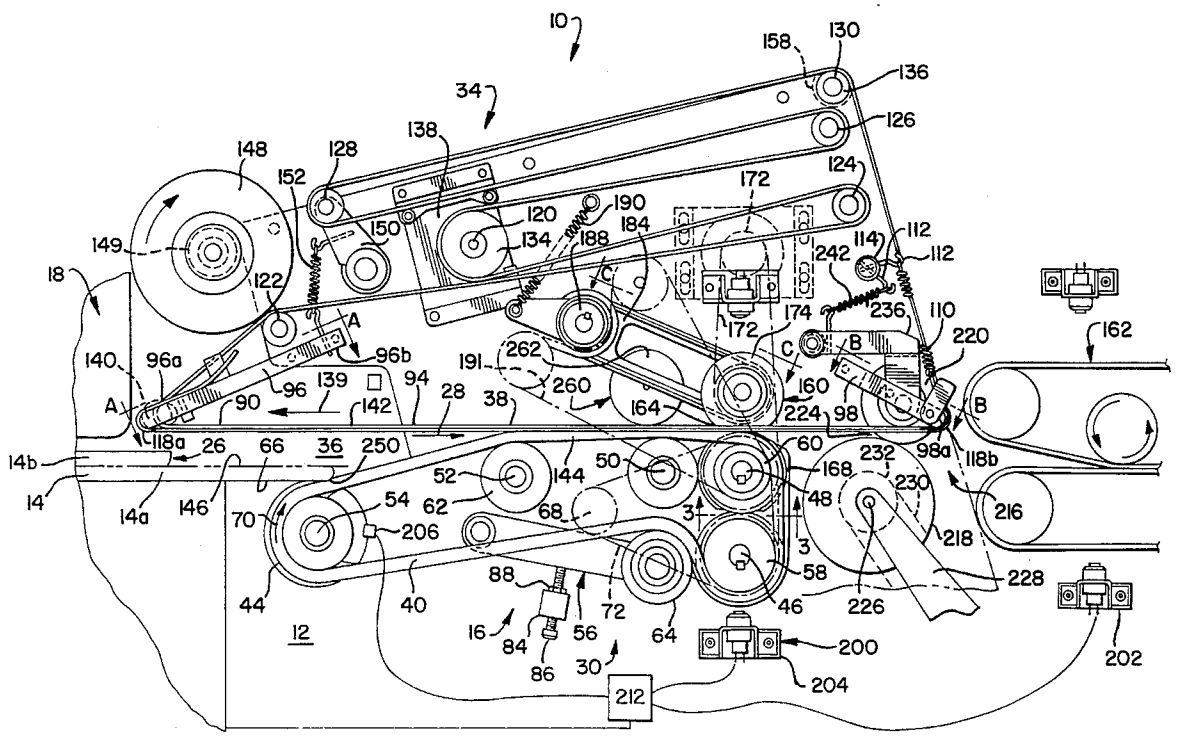
Attorney, Agent, or Firm—Welsh & Katz, Ltd.

[57] **ABSTRACT**

An apparatus for separating and advancing documents includes a first assembly having movable belts for frictionally engaging and advancing one of the documents along a path, and a second assembly having stationary belts and retrogressingly moving a portion of an endless belt along the path to frictionally engage and halt the remainder of the documents. The retrogressional movement of the endless belt distributing wear experienced by the engaging and halting of documents over the length of the endless belt. The movable belts of the first assembly and the belts of the second assembly are disposed in relative juxtaposition whereby the one document is gripped between the first assembly and second assembly and advanced along the path under the influence of the first assembly.

13 Claims, 5 Drawing Sheets



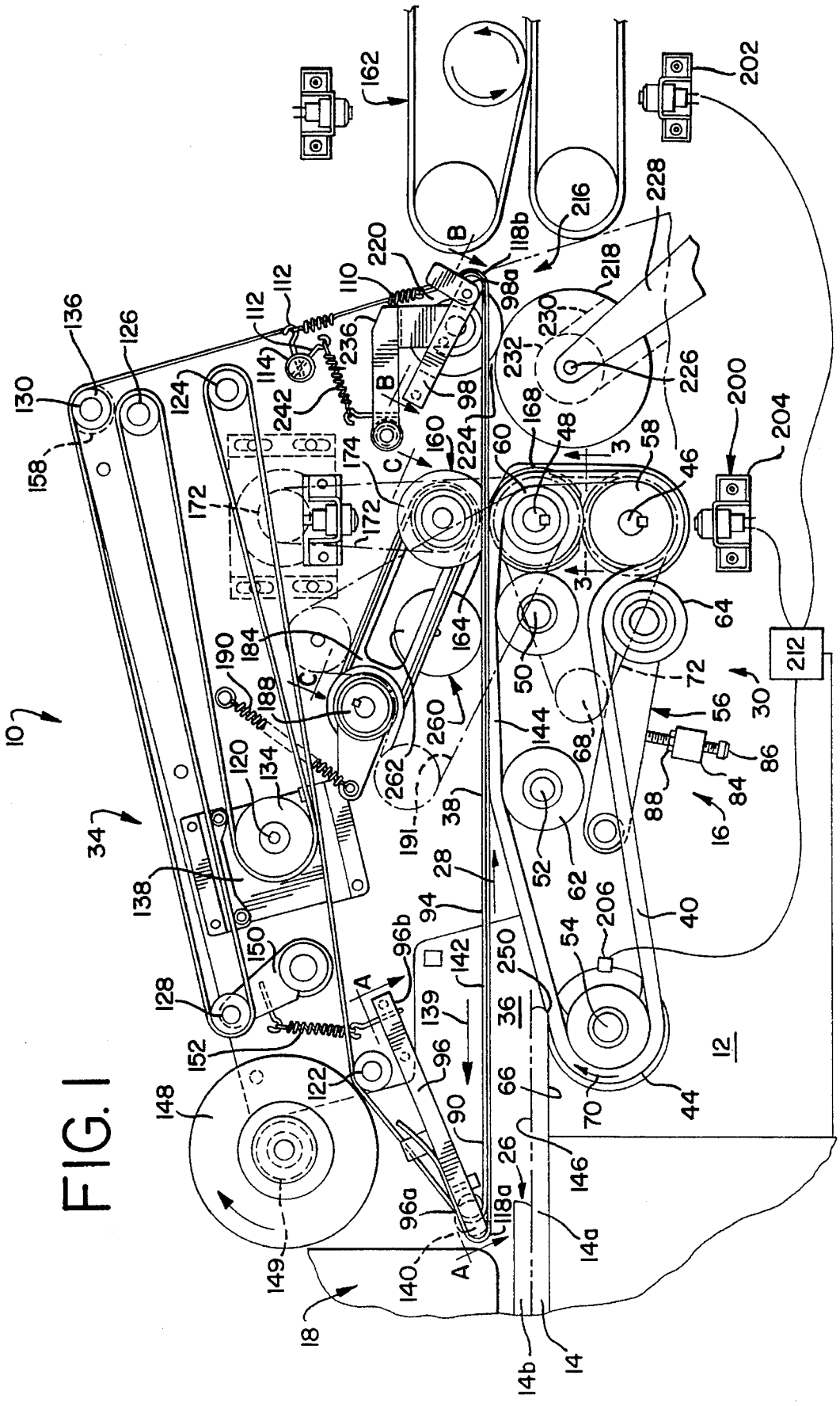


FIG. 1

FIG. IC

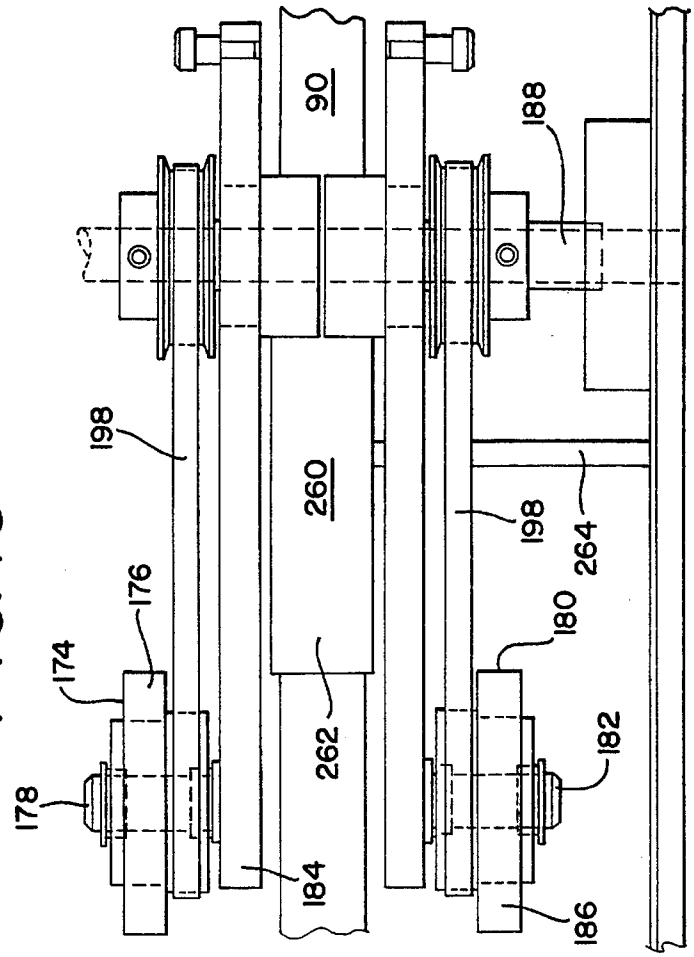

90
188
198
260
198
264
176
180
174
262
182
178
184
186

FIG. IA

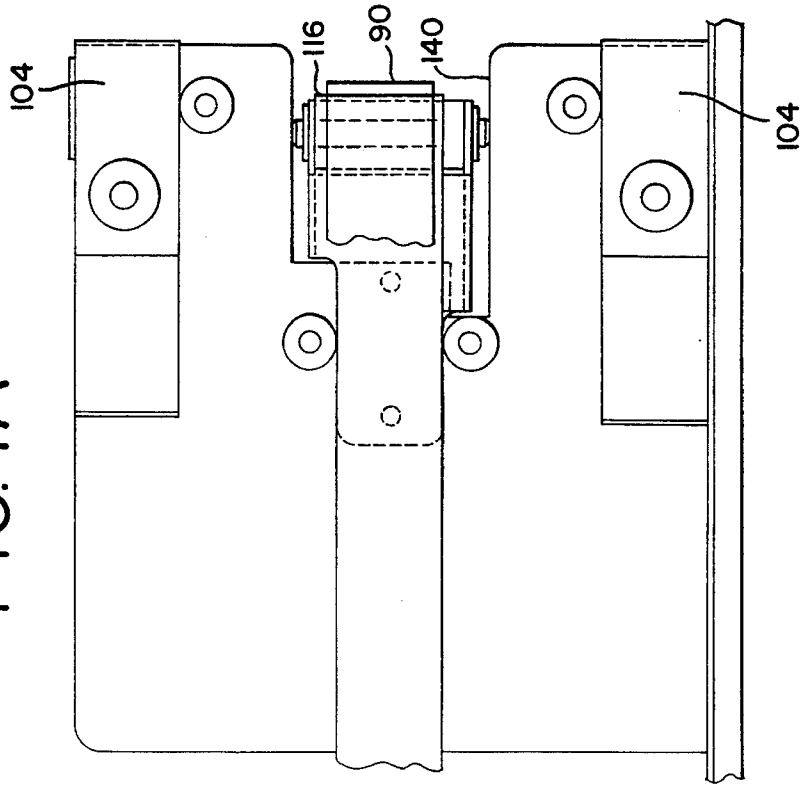
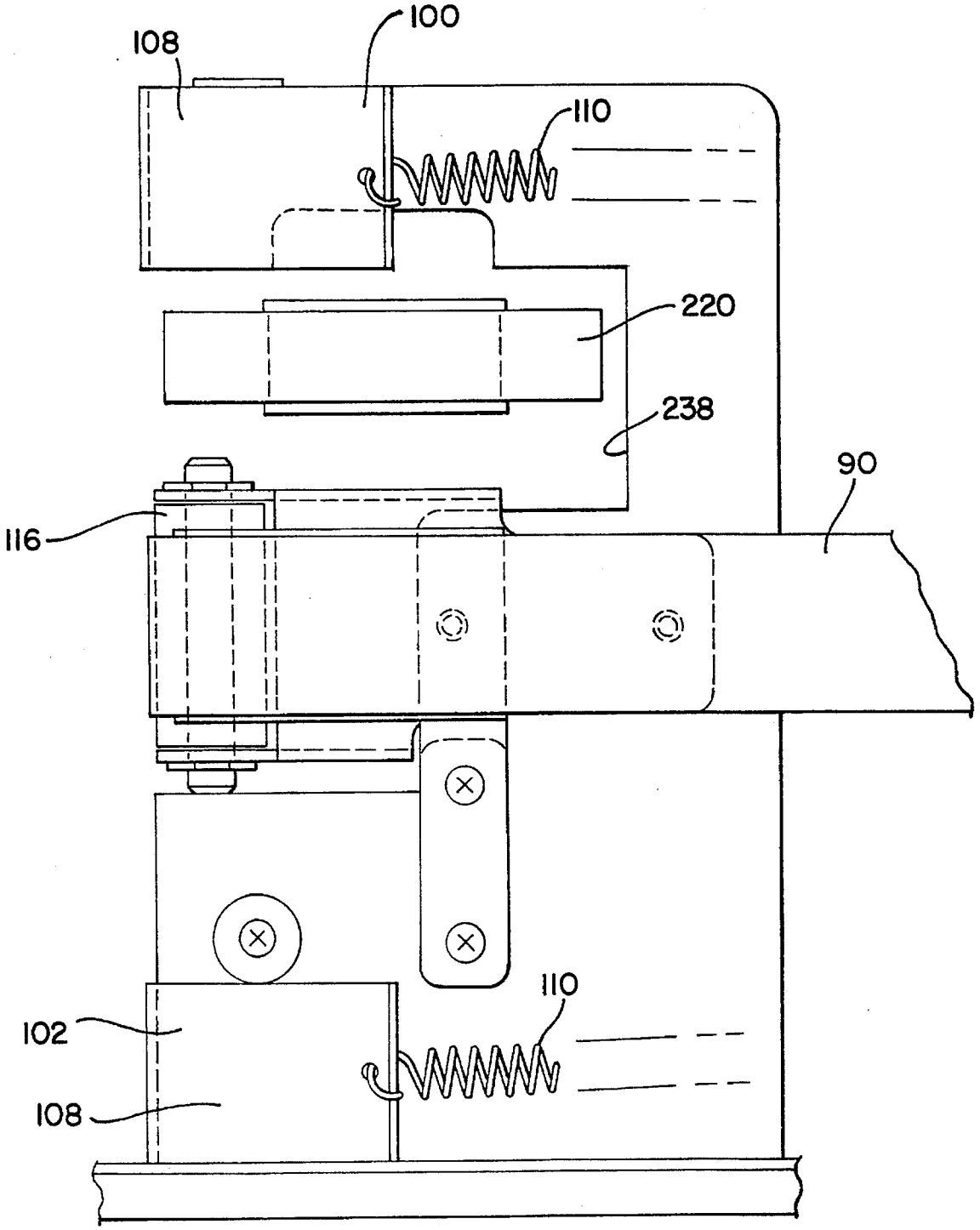

104
116
90
140
104

FIG. 1B



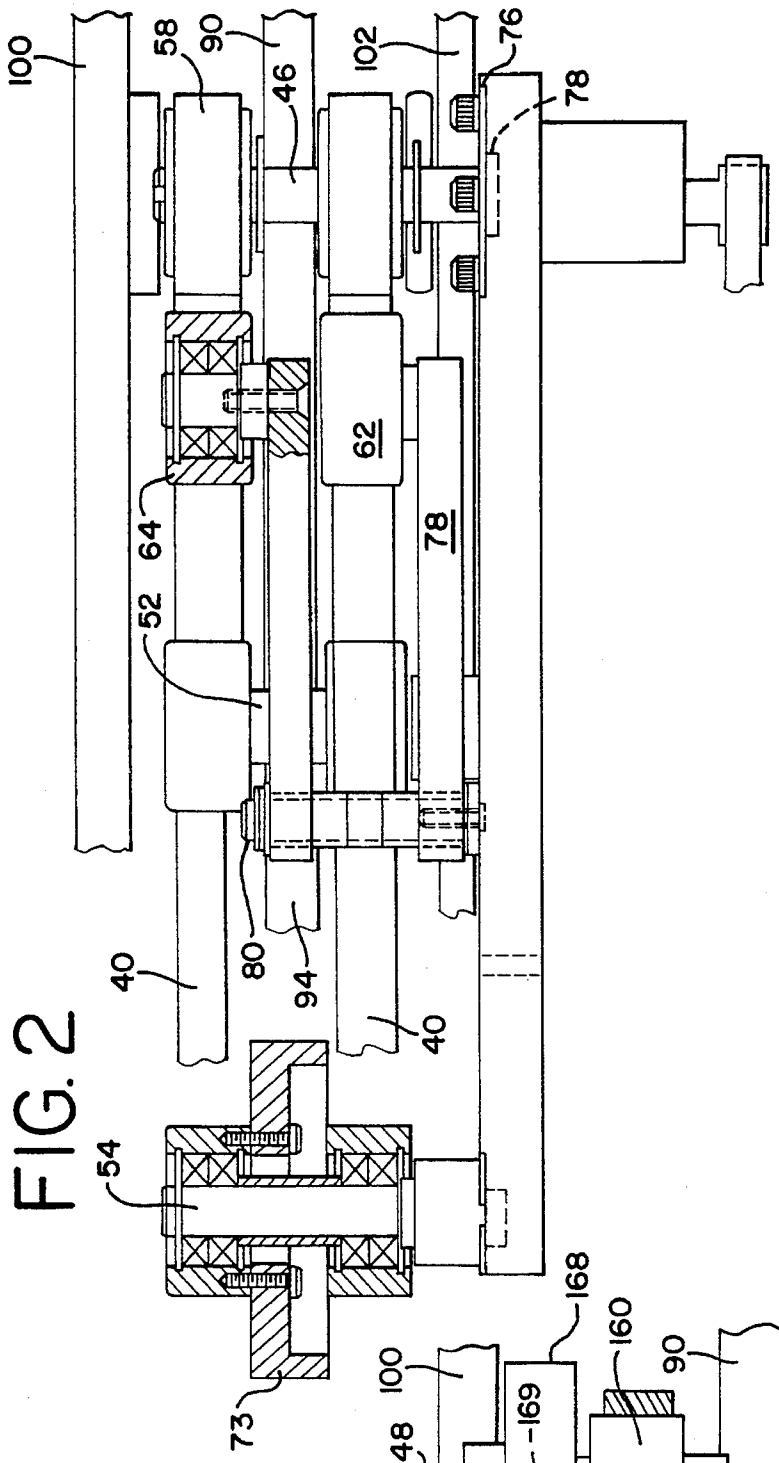

100
58
90
46
102
76
78
62
64
78
52
80
94
40
40
54
73

FIG. 2

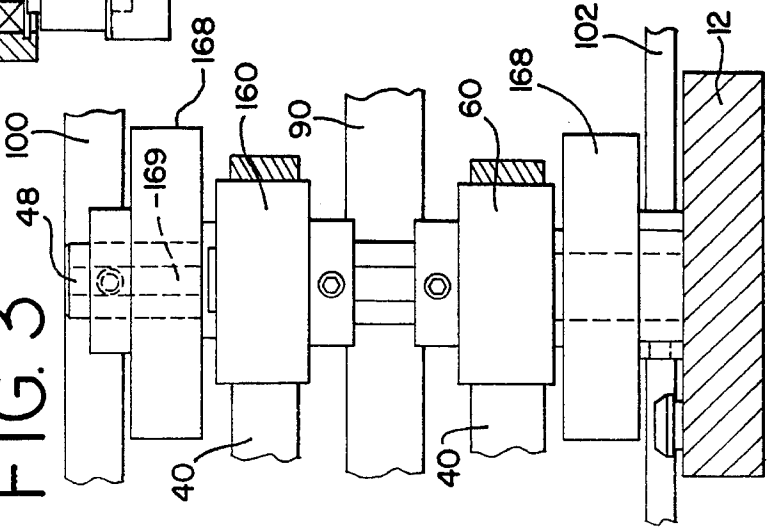

168
160
90
60
168
102
12
100
169
48
40
40

FIG. 3

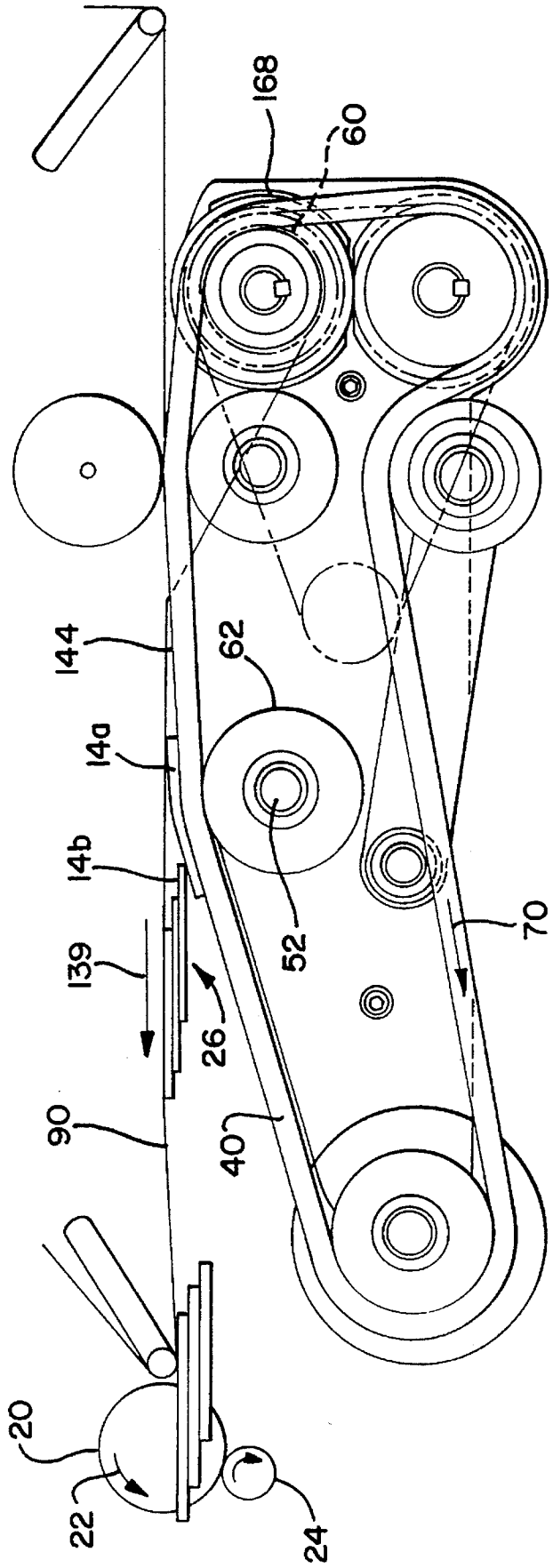


FIG. 4

HIGH SPEED SEPARATOR WITH MOVABLE HOLD BACK BELT FOR HIGH SPEED FLATS FEEDER

FIELD OF THE INVENTION

The present invention relates to automated sorting apparatus used to rapidly handle and sort large volumes of documents, and specifically to an apparatus for separating single pieces of so-called "flat mail" from large groups of such mail, even in situations when the mail is randomly collated as to size and type.

BACKGROUND OF THE INVENTION

Flat mail, or "flats" are terms used to refer to mail other than normal letter-sized envelopes, and includes magazines, oversized envelopes, and thin mailer sheets which are folded over in half, thirds, or quarters, and fastened by a staple, tape or adhesive. Presently, such mail requires a significant amount of handling by Postal Service personnel, due to the inability of commonly available automated mail handling equipment to quickly separate individual pieces of flat mail for reading and subsequent sorting.

Flats, as well as letter-sized envelopes, are usually fed in horizontal stacks of vertically oriented pieces to automated machinery, which separates or singulates individual pieces from the stack, positions each piece for manual or automatic reading of the Zip Code, and subsequent sorting of each piece to a bin corresponding to the Zip Code or a portion thereof, such as the last three digits. Regardless of whether the reading is done manually or automatically, the separation equipment must properly separate and position each document for fast and efficient reading without jamming. Also, the passage of "doubles", or two pieces temporarily stuck together, through the separation path is to be avoided.

Conventional equipment has the tendency to damage or mutilate flat mail during the separation process. Folded over pieces and magazine pages are often skewed and torn by being subjected to uneven conveyor roller or belt pressures, larger envelopes are often creased, crumpled or inadvertently folded, and smaller pieces sometimes temporarily adhere to larger ones.

Various systems have been proposed for providing trouble free and rapid automatic separation, singulation and sorting of flats. One such system is described in U.S. Pat. No. 5,257,777, incorporated by reference herein, and commonly owned by the assignee of this application. The described singulator uses a movable set of belts to frictionally engage one of the surfaces of an envelope within a shingled array of envelopes to separate and transport that envelope to a conveying path. The singulator also employs a set of hold back belts to frictionally engage and halt the advance of the other envelopes thereby allowing the separation. However, the frictional engagement to halt the advance of the other envelopes creates wear in the document separator which after the processing of large amounts of envelopes may impact the ability of the hold back belts to hold back the remainder of the envelopes. In addition, particularly when high volume separation is occurring, residue has a tendency to be deposited on the hold back belts by the envelopes. This residue may reduce the ability of the hold back belts to frictionally engage the other documents to halt their advance.

Thus, there is a need for an apparatus which rapidly separates and singulates flat mail with a relatively simple yet

cost effective configuration. There is also a need for such an apparatus which grips mail pieces of all sizes over a substantial surface area of each piece for rapid transmission along the separation path to prevent crimping of the mail piece. There is also a need for such a separator which accommodates pieces of flat mail of varying thicknesses, from thick magazines to single sheets, without jamming. There is a further need for a flat mail separator which is capable of separating as many as 10,000 pieces of mail per hour and accommodating the wear that such a high volume may create.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a flat mail separator and singulation apparatus for high volume mail processing which meets the above-identified needs by receiving an array of shingled documents from a document feeder, holding the shingled array at an entrance nip, separating a single document from the shingled array and advancing the separated document in a vertical orientation along a document path at high velocity. Additionally, the present invention maintains the ability to separate documents while processing a high volume of mail by distributing the wear which typically occurs at certain locations in the separator device.

More specifically, the present belt separator apparatus includes a moving first assembly for frictionally engaging and advancing one of the plurality of documents along a document conveying path, and a second assembly having a moving element for frictionally engaging and halting the advance of the remainder of the plurality of documents. The first assembly and second assembly each include a plurality of belts, and are disposed in juxtaposition whereby the one document is gripped between the first assembly and second assembly and advanced along the path between the two assemblies under the influence of the first assembly.

In a preferred embodiment, the moving element of the second assembly includes an endless hold back belt forming an inner reach portion along the document conveying path for halting the advance of the remainder of the documents and an arrangement for continuously retrogressing portions of the endless belt through the inner reach portion to distribute wear of the endless belt along the entire length of the belt.

Also, the belts of the moving and stationary elements are vertically spaced relative to each other such that they are interleaved, and contact the front and back surfaces, respectively, of the one document to provide a column strength to the one document over a substantial surface area as the document advances through the apparatus. In this manner, portions of the one document are prevented from being crimped between the first assembly and the second assembly element by denying the document lateral space where a crimp could form.

The apparatus preferably includes an accelerator mechanism for inducing a high velocity to the one document in the path after it has been separated from the shingled array. The one document is subsequently passed to additional handling equipment. Once the first document of the shingled array is advanced along the path, each document of the array is similarly advanced seriatim. In addition, a sensing mechanism is provided to monitor the number of documents in the apparatus and to control the document feeder appropriately to maintain a steady flow of shingled documents into the apparatus

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overhead plan view of the belt separator of the invention;

FIG. **1A** is a section taken along the line A—A of FIG. **1** and in the direction indicated generally;

FIG. **1B** is a section taken along the line B—B of FIG. **1** and the direction indicated generally;

FIG. **1C** is a section taken along the line C—C of FIG. **1** and in the direction indicated generally;

FIG. **2** is a front elevational view of the apparatus of FIG. **1** in partial section;

FIG. **3** is a section taken along the line of **3**—**3** of FIG. **1** and in the direction indicated generally; and

FIG. **4** is a diagrammatic overhead plane view of a representative shingled array of four documents indicated at the entrance nip of the present apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, the belt separator of the present invention is generally indicated at **10**. The separator **10** includes a support frame **12** preferably having a configuration which facilitates integration with other conventional mail handling and sorting apparatus. In FIGS. **1** and **2**, pieces of flat mail such as documents, flats, envelope or the like, generally designated at **14**, are advanced in a left-to-right direction as seen from a front **16** of the separator **10**.

A document feeder **18** is located just to the left of the apparatus **10** and is contemplated to be any one of various designs well known to skilled practitioners. However, a preferred feeder **18** (best seen in FIG. **3**) includes at least one conically shaped singling disk **20** which rotates axially in the direction indicated by arrow **22**. The document feeder **18** receives horizontal stacks of vertically positioned flat mail pieces **14**, each of which is oriented so that the addressed side faces the front **16** of the separator **10**. Through the action of the disk **20** and a back up roller **24**, the feeder **18** creates a shingled array **26** of the leading pieces or documents **14** of flat mail, designated **14***a* and **14***b*, respectively which are shingled so that the front most document **14***a* is advanced at a faster velocity that the subsequent document **14***b* in the shingled array. Although only three shingled documents **14** are depicted in FIG. **1**; it will be appreciated the additional documents are normally provided in the array.

The shingled array **26** encounters the separator **10** by being advanced into a path **28** defined by a moving first assembly **30** and a second assembly **34**. An entrance portion **36** of the path **28** is wedge or triangular shaped as viewed from above, due to the relative distances between corresponding portions of the first assembly **30** and second assembly **34**. To the right of the entrance portion **36**, and beginning at an entrance nip **38**, the path **28** is generally linear through the rest of the separator **10**.

The moving first assembly **30** is designed for frictionally engaging and individually advancing each one of the documents **14** in the shingled array **26** along the path **28**, while the second assembly **34** is designed for supporting each advanced document **14***a*, and also for frictionally engaging and halting the advance of the remaining documents, represented by the documents **14***b*, such that only one document at a time is passed through the separator **10**. In addition, the second assembly **34** provides the normal force to hold the document **14***a* against the first assembly **30** causing the document to advance through the separator **10**.

Referring to FIGS. **1** and **2**, the first assembly **30** preferably includes a pair of document drive belts **40**, which are made of resilient, durable material and preferably have a textured outer surface **44** to enhance friction contact between the belts **40** and the documents **14**. Although only two drive belts **40** are provided, depending on the application and size of the apparatus **10**, additional drive belts are contemplated.

The drive belts **40** are disposed in vertically spaced, parallel orientation relative to each other around a first or outer drive spindle **46**, a second or inner drive spindle **48**, three idler spindles respectively designated **50**, **52** and **54**, and tensioning roller assembly **56**. The outer drive spindle **46** has a pair of vertically spaced drive rollers **58**, the inner drive spindle **48** has a correspondingly spaced pair of drive rollers **60** and each of the idler spindles **50**, **52**, **54**, has a correspondingly spaced pair of idler rollers **62**. The tensioning roller assembly **56** also has a correspondingly spaced pair of idler rollers **64**. The belts **40** of the first assembly **30** thus define a vertical contact surface for engaging a front surface **66** of each of the documents **14**. A motor **68** drives the outer drive spindle **46** and inner drive spindle through a drive belt **72** so that the drive belts **40** follow a clockwise movement indicated by the arrows **70**.

In the preferred embodiment, idler spindle **50** is mounted more closely adjacent the path **28** than spindle **52** to extend the central position of belts **40** outward as they pass adjacent the second assembly **34**, thereby increasing the frictional contact between the belts **40** and the documents **14** as the documents pass through this point of the separator **10**.

The idler spindle **54** is linearly and spatially displaced and slightly offset forwardly from spindle **52** to define the generally triangular shaped entrance portion **36**. Thus at spindle **54**, the first assembly **30** is at a first, relatively distant position relative to the second assembly **34**, while at the spindles **48**, **50**, **52** the first assembly and second assembly are in closely adjacent relationship to each other. To prevent envelopes from contacting the left end of the assembly **30**, a spacer roller **73** may be placed about spindle **54** between the rollers **62**. The spindles **50**, **52**, **54** are mounted to the frame **12** by brackets **74** equipped with bearings **76** as are well known to skilled practitioners.

The tensioning roller assembly **56** selectively adjusts and maintains the tension of the drive belts **40**. Each of the idler rollers **64** are mounted to one end of a corresponding pivot arm **78** with the other ends of the pivot arms pivotally mounted to a vertical post **80** which is fixedly attached to the support frame **12**. Attached to the frame **12** and located along the length of the pivot arms **78** is a vertical stub post **84**. A positioning bolt **86** for each of the pivot arms **78** is threaded through the member **84** with the end of the bolts contacting the pivot arms to selectively pivot the pivot arms and force the idler rollers **64** against the drive belts **40** to selectively tension the drive belts **40**. A locking nut **88** may be threaded about the positioning bolt **86** to lock the position of the bolt once the desired tension in the drive belts **40** is achieved.

Referring to FIGS. **1**, **1A**, and **1B**, the second assembly **34** includes an endless holdback belt **90** with an inner reach **94** extending generally along the path **28**. The belt **90** is driven so that the inner reach **94** moves from right to left as viewed in FIG. **1**, in a direction opposite the direction of advancement of the singulated document **14***a* or in a retrogressing direction. Preferably the belt **90** moves at a slow speed such as approximately 6 inches per minute.

The second assembly **34** also includes a vertical plate **96**

located on the left in FIG. **1** and vertical plate **98** located along the right in FIG. **1**. Each of the vertical plates **96, 98** is secured to the support frame **12** and has an inner end **96***a* and **98***a* located closely adjacent the path **28**. The left plate **96** is angled relative to the path **28** so that the inner end **96***a* is upstream of the outer end **96***b*. The right plate **98** is angled opposite to the left plate **96** with the inner end **98***a* downstream of the outer end **98***b*.

Referring also to FIG. **2**, a pair of stationary hold back belts **100, 102** are mounted horizontally and extend from the left plate **96** to the right plate **98**, facing the front **16** the separator **10** in a generally vertically spaced relationship relative to each other. For each belt **100, 102**, a first end **104** is wrapped around the inner end **96***a* of the left support plate **96** to avoid creasing or folding and is secured to the rear side **106** of the plate **96**. A second end **108** of each belt **100, 102** is wrapped around the inner end **98***a* of the right plate **98** and is secured to one end of a biasing spring **110**. The other end of each of the biasing springs **110** is attached to a hook bolt **112** which is fixedly anchored to a vertical support post **114** attached to the support frame **12**. In this manner, the springs **110** maintain a predetermined tension on the belts **100, 102** which keeps them taught, yet provides slack when the force of spring **110** is overcome, such as when a thick document is advanced along the path **28**.

Referring back to FIG. **1**, interdisposed between the belts **100, 102** and journaled to the inner end **96***a* of the left plate **96** and inner end **98***a* of the right plate **98** are idler rollers **116**. The idler rollers **116** support the moving belt **90** to form the ends **118***a*, **118***b* of the inner reach portion **94**. The moving belt **90** also extends around a drive spindle **120** and five idler spindles **122, 124, 126, 128** and **130**. The drive spindle **120** has a roller **134** and the idler spindles **122, 124, 126, 128** and **130** have idler rollers **136**. The idler spindles **122,124,126, 128 130**, and drive spindle **120** are generally alternately disposed on the left and right sides of the second assembly **34** to lengthen the total length of the moving belt **90** relative to the length of the inner reach **94**. A motor **138** drives the drive spindle **120** to rotate in the clockwise direction thereby moving the belt **90** in the direction of arrow **139** and continuously retrogresses the portion of the belt **90** forming the inner reach **94** and pulling that portion out of the path of the documents to distribute the wear over the entire length of the belt **90**.

Referring to FIGS. **1**A and **1**B, in the preferred embodiment, the upper and lower stationary belts **100, 102** define a vertical plane which is substantially parallel to the plane defined by the drive belts **40** along the path **28**. The idler roller **116**, rotatably mounted to the left plate **96**, is disposed within a notch **140** formed in the inner end **96**a of the plate **96** so that the left end **118***a* of the inner reach **94** is slightly recessed from the plane defined by belts **100, 102**. The idler roller **116**, rotatably mounted to the right plate **98** is disposed so that the moving belt **90** is between and is substantially vertically aligned with the stationary upper and lower belts **100, 102**. The coefficient of friction (μ) of the upper and lower belts **100, 102** is preferably less than the μ of the middle moving belt **90** thus making it easier for the document to glide along the upper and lower belts compared to the moving belt.

The differential in μ between the upper and lower stationary belts **100, 102** and the middle belt **90** is useful due to the fact that these belts perform three basic functions: a) they offer a lateral normal force for the drive belts **40** to work against; b) they constrain and support pieces of flat mail **14** with a column strength so they cannot roll or be folded, bent or crumpled; and c) they provide a hold back force so that "doubles" or two documents temporarily stuck together will not proceed past the nip **38** (FIG. **1**).

Referring also to FIG. **2**, placing the idler roller **116** in the notch **140** formed in the left support plate **96** places a left end portion **142** of the inner reach **94** of the moving belt **90**, defined as extending between the left end **118***a* of the inner reach **94** and nip **38**, rearward of the plane defined by belts **100, 102**. Thus the moving belt **90** with its higher coefficient of friction, does not contact document **14***a* as the document advances toward nip **38**. This eliminates the possibility of the moving belt **90** disadvantageously applying a hold-back force to document **14***a* in opposition to the forces applied by drive belts **40**. At nip **38**, all three belts **90, 100, 102** are coplanar and a hold back force is applied by belt **90** and in the region of the belt separator **10** beyond, or to the right of nip **38**, as viewed in FIG. **1**.

The moving drive belts **40** have a higher μ on the outer surface **44** than the highest μ of the stationary belts **100, 102** and moving belt **90**. This relationship is important to enable the drive belts **40** to overcome the holding force of the hold back belts **90, 100, 102** and to advance documents along the path **28**.

Referring again to FIGS. **1** and **2**, it will become evident that while the drive belts **40** of the first assembly **30** define a first vertical planar contact surface and the belts **90, 100, 102** of the second assembly **34** generally define a second vertical planar contact surface, the relative spacing of the drive belts **40** and the hold back belts **90, 100, 102** is such that each of the drive belts is located in a vertical orientation between the stationary belts **100, 102** and the moving belt **90** and never contact the hold back belts. This relationship is designed to reduce wear on the moving drive belts **40** when documents are not being advanced along the path **28**, which would otherwise occur if the first assembly **30** and second assembly **34** were positioned in opposing, contacting relationship.

It will also be evident from FIG. **1** that a portion **144** of the first assembly **30**, defined by the portion of belt **40** extending adjacent spindles **48, 50**, and **52**, is positioned so that the drive belts **40** begins to project across the path **28** at nip **38** and continue the projection until spindle **48**, with the greatest amount of projection being adjacent spindle **50**. This occurs because spindles **48, 50** are mounted closer to the path **28** than spindle **52** but the idler roller **60** on spindle **48** has a smaller diameter than the idler roller **62** on spindle **50**. This arrangement is preferred so that sufficient pressure is exerted by the drive belts **40** on each flat document **14** to ensure its advance along the path **28**.

As the drive belts **40** advance each of the documents **14***a* by frictionally engaging the front surface **66** of the documents, rear surfaces **146** of the documents frictionally rub against the upper and lower stationary holdback belts **100, 102** and moving belt **90**. This frictional rubbing may cause the wearing of the surfaces of the hold back belts **90, 100, 102** leading the belts to develop wear spots, particularly opposite the portion **144** of the first assembly **30** where the drive belts **40** project in between the hold back belts. To reduce the wear cause by the frictional rubbing, the upper and lower stationary belts **100, 102** are preferably composed of a slick material with a very low coefficient of friction. The slick material may be nylon or a teflon coated material or the like. Making the upper and lower holdback belts **100, 102** of a material having a low coefficient of friction still allows the belts to offer a lateral normal force for the drive belts **40** to work against and also constrain and support the documents with column strength.

As noted above, the wear caused by the frictional rubbing of the documents **14***a* on the hold back belt **90** is distributed over the length of the belt **90** by moving the belt around the drive spindle **120** and idler spindles **122, 124, 126,128, 130** so that the portion of the belt forming the inner reach **94** is changed. Also, to provide a long length of the hold back belt **90** for distribution of the wear, the belt is wound around the drive spindle **120** and idler spindles **124, 126, 128** and **130** alternately disposed on the left and right sides of the second assembly **34**, as seen in FIG. **1**.

In addition to wear, the rubbing friction may cause the deposit of residue from the rear surface **146** of the document **14** on the surface of the moving hold back belt **90**. To remove this residue, the second assembly **34** may include a rotary brush **148** which brushes the surface of the belt **90** after the belt has travelled through the inner reach portion **94**. The rotary brush **148** may be driven by a motor **149** and is preferably disposed opposite idler spindle **122** with the corresponding idler roller **136** offering a lateral normal force to work against.

One of the idler spindles **128** is rotatably mounted on one end of a pivot arm **150** with the other end of the pivot arm secured to the frame **12**. The pivot arm **150** is biased by a spring **152** attached to the outer end **96***b* of the left support plate **96**. In this manner, the spring maintains a predetermined tension on the belt **90** which keeps the belt taught, yet provides slack when the force of the spring is overcome, such as when a thick document is advanced along the path **28**. The idler spindles **122, 124, 126** and **128** are rotatably mounted to the frame **12** by bearings **158** housed in the frame **12** as is well known to skilled practitioners.

Referring to FIGS. **1** and **3**, an accelerator roller assembly, generally designated **160**, is positioned to engage individual flat documents **14**, and initially the document **14***a*, in the path **28** to complete the separation from the shingled array **26**. The accelerator roller assembly **160** is provided to increase the velocity of the lead document **14***a* to be processed by additional handling equipment such as a high speed conveying apparatus **162**.

In the preferred embodiment, the accelerator roller assembly **160** includes two opposing pairs of driven or powered rollers which straddle the path to form a nip **164**. The first pair of driven rollers **168** are mounted on a spindle **169** within the inner drive spindle **48**. The driven rollers **168** may be driven by two different driven mechanisms. The driven rollers **168** may be driven through a one way clutch and gear ratio connection between spindle **179** and the inner drive spindle **48** so that rotation of the idler rollers **60** by movement of the drive belts also drives the accelerator rollers **168** at a slightly higher rotational speed than the rollers **60**. In addition, the clutch connection allows the accelerator rollers **168** to be rotated independently of the idler rollers **136** by a suitable drive means such as a motor **170** through a drive belt **172** extending about spindle **169**.

As will be evident from FIG. **3**, the rollers **168** are vertically spaced on the spindle **48** to provide the accelerated document with further column support, while being horizontally aligned so as not to interfere with the drive belts **40** or the hold back belts **90, 100, 102**. Referring back to FIG. **1**, in addition the circumferential surfaces of the rollers **168** project into the document path **28** farther than the outer surface **44** of the drive belts **40** as the drive belts extend about the idler rollers **60**, to engage the front surface **16** of the document. This arrangement is preferred to prevent the drive belts **40** from engaging and holding back the document **14** when the accelerator rotors **168** are driven by the motor **170** and the drive belts **40** are stationary.

Referring to FIGS. **1** and **1C**, a second pair of accelerator drive rotors **174** include an upper accelerator roller **176** mounted to an upper spindle **178** and a lower roller **180** mounted to a lower spindle **182**. The upper spindle **178** and lower spindle **182** are respectively mounted to one end of corresponding pivot arms **184** and **186**. The other end of the upper and lower pivot arms **184, 186** are pivotally mounted to vertical spindle **188** and biased by springs **190** for engagement at the nip **164** as well known in the art. The accelerator rollers **176, 180** are driven by the motor **170** through extension of drive belts **191** about the accelerator spindle **169**, a pair of idler rollers **192** and spindle **188**. The rotation of spindle **188** rotates pullies **196**, drive belts **198** and accelerator rollers **176, 178**.

Referring to FIG. **1**, the separator apparatus **10** is also preferably provided with a sensor system, generally designated **200**, for monitoring the presence of documents **14** in the path **28** so that a relatively constant flow of documents is advanced along the path. Although the sensor system **200** may take many forms is as well known to skilled practioners, in the preferred embodiment the system includes a set of two (2) photocells **202** and **204** which are connected to control module, shown diagrammatically at **212**. The module **212** is also connected to a set of sensors shown diagrammatically at **206** and a control element (not shown) for the document feeder **18**.

The photo cell **202** is preferably located in the high speed conveying apparatus **102** and straddles or throws the beam across the path **28** to detect a gap or spacing between documents. Such gap is indicative of a lack of documents **14** in the path **28** and a signal generated by the photo cell **202** triggers a command by the control module **212** to activate the drive motor **170** to drive the accelerator roller assembly **160**. When the beam from photocell **202** is interrupted, a signal by the photocell triggers a command by the control module to deactivate motor **170** and cease driving the accelerator rollers **168, 174**.

The photo cell **204** is preferably located at the nip **164** formed by the accelerator roller assembly **160** and is also positioned to straddle the path **28**. When each document **14** passes the photo cell **204**, the beam is interrupted which generates a signal to the control module **212** to deactivate the motor **138** stopping the drive belts **40** from advancing documents to the accelerator roller assembly **160**. In the absence of a document, the beam is not interrupted and the drive belts **40** engage and transport document **14***a* to the accelerator roller assembly **168**.

The photo cells **206** and may include a plurality of photocells are preferably located from the document feeder to the entrance nip **38**. The photo cells **206** are positioned to straddle the path **28** and in dependence on whether the photo cells **206** are blocked and the drive belts are activated or stationary, the control module **212** activates or deactivates the document feeder **18**.

It will be appreciated that the sensor system **200** will result in intermittent operation of the feeder **18** and resulting intermittent feeding of documents **14** onto the path **28**. However, the flow of documents along the path **28** will be relatively uniform. Further, it is contemplated that other equivalent sensing devices commonly known in the art, including, but not limited to encoders may be positioned in operational relationship to the separator **10** to achieve the above identified relatively constant flow of documents through the separator **10**.

A transport roller assembly is generally designated at **216**

and is positioned to engage flat documents being advanced by the accelerator roller assembly **160** and transport the documents through the space or gap between the singulator **10** and high speed conveying apparatus **102**. In the preferred embodiment, the transport roller assembly **216** is mounted just to the right of the accelerator roller assembly **160**, however, other mounting positions are contemplated.

The transport roller assembly includes a driver roller **218** and an idler roller **220** which straddles the path **28** to form nip **224**. The driver roller **218** is attached to a spindle **226** and the roller and spindle are mounted to a pivot arm **228** pivotally secured to the frame **12**. The arm is biased for engagement at the nip **224** by a spring (not shown) as is well known in the art. The driver roller **218** is driven by a drive belt **230** and pulley **232** which is driven by a drive means (not shown) forming a part of the high speed conveying apparatus **102**.

The idler roller **220** is rotatably mounted to an "L" shaped bracket **236** and extends through a notch **238** (FIG. 1B) formed in the right vertical support plate **98**. The bracket **236** is rotatably mounted to a vertical rod **240**. To bias the idler roller **220** into engagement with the driver roller **218**, a spring **242** is attached to the bracket **236** with the other end of the spring operatively attached to hook post **112**.

In operation, and referring to FIGS. **1** and **4**, once the control module **212** is triggered to activate the document feeder **18**, a shingled array **26** of documents **14** is fed into the entrance portion **36** of the separator **10**. Each shingled array **26** includes a forward most lead document **14***a* which is moving faster than subsequent document as it reaches the entrance nip **38**. At a point **250** (best seen in FIG. **1**), the front surface **66** of the document **14***a* would be engaged by the outer surface **44** of both drive belts **40**. Since the μ of the surface **44** is greater than the μ between the first document **14***a* and the second document **14***b*, the document **14***a* is pulled forward toward the entrance nip **38** by the belts **40**.

During this time, the second document **14***b* and any other documents in the array **26** engage hold back belts **90**, **100**, **102** of the second or hold back assembly **34**. The document feeder **18** pushes the array **26** toward the entrance nip **38**. Since the document **14***a* is traveling along the path **26** at a greater velocity than the remainder of the array **26**, it reaches the nip **38** first, and then is advanced into the portion **144** of the moving first assembly under the influence of belt **40**.

In portion **144** of the separator **10**, the disposition of the drive belts **40** and the hold back belts **90**, **100**, **102** defines substantially vertical, opposer planar contact surfaces which extend over a substantial planar area relative to the front surface **66** and rear surface **146** expectively, of the document **14***a* being contacted by the moving belts **40** to move the document along the path **28**. Thus, both the drive belts and moving and stationary hold back belts combine to provide column strength to the documents **14** held therebetween as the documents are advanced along the path. This column support prevents each document from being bent, rolled, crumpled or otherwise damaged during the separation process for retaining each document in a confined spaced during advancement.

As seen in FIG. **4**, in conjunction with FIG. **3**, the hold back belts **90**, **100**, **102** conform to the shape of the document array **26** due to the biased mounting of the belts **100**, **102** and the extension of the belt **90** about the idler spindle **130** mounted on the biased pivot arm **150**. These mounting arrangements provide the hold back belts **90**, **100**, **102** with the necessary slack to conform to documents of varying thicknesses. It will be appreciated to achieve the desired column support, the document occupies a significant portion of the lateral space between the moving first assembly **30** and the hold back assembly **34**. As the initial document **14***a* passes the entrance nip **38**, the position of the drive belts **40** ensures a positive engagement of the document between the first and second assemblies **30** and **34**. Specifically, the drive belts **40** extend rearwardly across the path **28** into the plane defined by the hold back belts **90**, **100**, **102**.

The positioning of the idler roller **62** mounted on spindle **52** provides a normal force which exerts a pressure on the held back document **14***b* which causes it to be engaged by the moving hold back belt **90**. This belt preferably has a higher μ than the hold back belts **100**, **102** and exerts a holding force on the document **14***b*, as well as any other documents in the array **26**, as illustrated in FIG. **4**. The retrogressive movement of belt **90** is slow enough to prevent the moving of the array **26** out of the nip **38** during separation of the documents **14**.

Additionally, the placement of the spindle **50** closer to the path **28** than spindle **52** with both spindles having generally equal size rollers forces belts **40** toward hold back belts **90**, **100**, **102** to provide additional normal force along the operative length of belts **40** at portion **144** of the first assembly **30**. This prevents slack in belts **40** between nip **38** and the drive roller **60**, and maintains belts **40** in engagement with document **14***a*.

As the drive belt engages the front surface **66** of the lead document **14***a* and separates the document from the array **26**, the rear surface **146** of the document rubs along the hold back belts **90**, **100**, **102**. The dragging of the document **14**a creates little wear of the stationary hold back belts **100**, **102** due to their low coefficient of friction (μ); however, the dragging does generate a certain degree of wear on the hold back belt **90**. The dragging of the forward document **14***a* against the hold back belt **90**, is primarily concentrated in or in close proximity to the portion **144** of the first assembly and with the high volume of documents typically being separated in the singulator **10**, even a small degree of wear may eventually generate a wear area on the belt **90**. Therefore, as a separator **10**, is separating the documents, the second assembly **34** creates a continuous movement of the belt **90** in the direction of arrow **139** to continuously retrogress the length of belt forming the belt portion which extends along the path **28** to distribute the wear over the entire length of belt.

Once the initial document **14***a* is advanced through the portion **144** of the separator **10**, the moving drive belts **40** contact the front surface of document **14***b* and overcome the holding force of the hold back belt **90** to advance the document **14***b* into the path **28** in the same manner as the document **14***a*. Each document **14** in the shingled array **26** will be similarly advanced seriatim through the separator **10** until, with the passage of the last document, a gap is sensed by the photocells **206** to trigger the feeder **18** to advance another array **26** to the entrance nip **38**. Documents **14** can be continually or intermediately fit through separator **10** depending upon the requirements of the equipment downstream of the separator.

Referring to FIGS. **1** and **1C**, an additional feature of the separator **10** is shown. This feature relates to the distributing of the contact between the hold back belt **90** and the document **14***a* along the length of the document particularly when thick documents are being separated by the separator **10**. It is believed that when a thick document **14***a* is separated and passes through the portion **144** between the entrance nip **38** and accelerator roller assembly **160**, the

contact force between hold back belt **90** and document **14***a* becomes concentrated at the forward and rearward edges of the document. Such a concentrated force may cause a high degree of wear on the belt **90**. To distribute the force over the length of the contact between the belt **90** and document **14***a*, the separator **10** includes a biasing roller, indicated at **260**. The assembly **260** includes a roller **262** composed of a material which may be compressed and offer a biasing force opposing the compression. Such materials may include foam or the like. The roller **262** is mounted on spindle **264** such that the outer circumferential surface of the roller contacts the rear surface of the moving belt **90**, as viewed from the front **16** of the separator **10**. As the belt **90** is retrogressed through the document path **28**, the roller **262** may rotate about the spindle to maintain contact with the belt **90**, but offer little resistance to its movement. When a thick document **14***a* passes through the portion **144** and pushes the belt **90** rearward, the roller **262** contacts the rear surface and presses the belt **90** against the document **14***a* so that the contact force is distributed.

A specific embodiment of the novel High Speed With Movable Hold Back Belt for High Speed Flats Feeder according to the present invention has been described for the purposes of illustrating the manner in which the invention may be made and used. It should be understood that implementation of other variations and modifications of the invention in its various aspects will be apparent to those skilled in the art, and that the invention is not limited by the specific embodiment described. It is therefore contemplated to cover by the present invention any and all modifications, variations, or equivalents that fall within the true spirit and scope of the basic underlying principles disclosed and claimed herein.

What is claimed is:

1. An apparatus for separating and advancing documents, said apparatus comprising:

a first assembly for frictionally engaging and advancing one of said documents along a path;

a second assembly for frictionally engaging and halting the advance of the remainder of said documents;

said first assembly and said second assembly being disposed in juxtaposition whereby said one document is gripped between said first assembly and said second assembly and advanced along said path under the influence of said first assembly;

said first assembly including first contact surface means which extend over a first substantial planar area relative to a first surface of said one document being contacted by said first assembly;

said second assembly including second contact surface means which extend over a second substantial planar area relative to a second surface of said one document being contacted by said second assembly, said first assembly and said second assembly contacting said first and second surfaces, respectively, of said one document over said first and second substantial planar areas thereby preventing portions of said one document from being crimped between said first assembly and said second assembly; and

said second assembly including belt means extending adjacent said path for supporting said one document, said belt means comprising at least one fixed belt having a first coefficient of friction, and at least one moving belt having a second coefficient of friction.

2. The apparatus of claim **1** wherein said moving belt includes an endless belt and said second assembly includes means for retrogressingly moving said moving belt means adjacent said path to distribute wear along the entire length of said endless belt.

3. The apparatus of claim **2** wherein said second assembly includes brush means operably contacting said endless belt to remove residue from said endless belt.

4. The apparatus of claim **1** wherein said second assembly includes means for resilient lateral movement of said at least one fixed belt and said moving belt as said one document moves along said path in the grip of said movable element and said fixed belt means.

5. The apparatus of claim **4** including means contacting a surface of said moving belt opposite said path for applying a biasing force agains said moving belt in opposition to said lateral movement of said moving belt.

6. The apparatus of claim **1** further including accelerator means means forming a nip along said path for engaging said one document as said one document advances along said path and for increasing the velocity of said one document along said path.

7. The apparatus of claim **6** wherein said first assembly comprises movable belt means extending about at least one drive rollers and a plurality of idler rollers, said acclerator means including at least one accelerator roller forming a portion of said nip, said acclerator roller being operationally engaged to at least one of said idler rollers and said drive roller.

8. The apparatus of claim **7** further including first and second sensing means for sensing the presence of documents at predetermined points along said path; and

control means connected to said first sensing means, said second sensing means, said first assembly and said accelerator means, said control means operationally engaging said accelerator means when said first sensor senses the absence of a document and operationally engaging said first assembly when said second senses the absence of a document.

9. The apparatus of claim **1** wherein said first assembly comprises movable belt means having a first portion defining a document entrance means, and a second portion for applying a force to said one document to grip said one document between said one second portion of said of said movable belt and said second assembly;

said second portion of said movable belt means extending about at least one drive rollers and a plurality of idler rollers, one of said idler rollers extending said second portion of said belt means towards said second assembly to enhance the gripping of said one document by said movable belt means and said second assembly.

10. The apparatus of claim **1** wherein said first assembly comprises movable belt means having a first portion defining a document entrance means, and further including first sensing means for sensing the absence of documents in the path; and

second sensing means for sensing when said plurality of documents is located at said document entrance means.

11. An apparatus for separating and advancing documents, said apparatus comprising:

a first assembly for frictionally engaging and advancing one of said documents along a path;

a second assembly for frictionally engaging and halting the advance of the remainder of said documents;

said first assembly and said second assembly being disposed in juxtaposition whereby said one document is gripped between said first assembly and said second assembly and advanced along said path under the

influence of said first assembly;

said first assembly including first contact surface means which extend over a first substantial planar area relative to a first surface of said one document being contacted by said first assembly;

said second assembly including second contact surface means which extend over a second substantial planar area relative to a second surface of said one document being contacted by said second assembly, said first assembly and said second assembly contacting said first and second surfaces, respectively, of said one document over said first and second substantial planar areas thereby preventing portions of said one document from being crimped between said first assembly and said second assembly;

said second assembly including belt means extending adjacent said path for supporting said one document, said belt means including at least one stationary belt and at least one belt having a portion moving retrogressingly along said path, said stationary belt and said moving portion being located apart from each other in vertically spaced relationship and defining spaces between said stationary belt and said moving portion, said first assembly comprising a plurality of movable belts whereby each of said movable belts has a portion thereof extending adjacent said spaces between said stationary belt and said moving portion.

12. The device of claim **11** wherein said second assembly includes at least two stationary belts.

13. The device of claim **12** wherein said retrogressingly moving portion is disposed vertically between said stationary belts.

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